Hideaki OHBA*: **Notes towards a monograph of the genus *Orostachys* (Crassulaceae) (1)****

大場秀章*: ベンケイソウ科イワレンゲ属植物覚書 (1)

This paper aims to provide taxonomically for a monograph of the genus *Orostachys* (DC.) Fisch., which is a part of a revision of the Asiatic species of Sedoideae (see Ohba 1980-1982). *Orostachys* comprises about 10 species confined to Asia and is characterized by the monocarpic rosulate habit with densely paniculate or racemose inflorescences, flowers with petals more or less united at the base, and stipitate ovaries (Ohba 1978). In my observation, the species of this genus have a rather wide range of variation, particularly in vegetative features, such as the shape and size of rosulate and cauline leaves, the length of spine and the degree of development of the cartilaginous appendages in the apical part of rosulate leaves. In *O. japonicus* the variation of the shape and size of rosulate leaves is suspected to show a geographical cline. *O. malacophyllus* shows an extremely wide range of variation in the height of stem, the shape and size of rosulate leaves and even in the size of flowers, but it is uncertain whether the variation of these characters shows geographical cline or not. Moreover, *O. malacophyllus* has several close relatives differing from it with some peculiarities such as stoloniferous or glaucous nature. Except these two species, our knowledge on the species of *Orostachys* is quite insufficient, particularly those distributed in continental Asia including China and USSR.

I owe the major part of this paper to the specimens preserved in various herbaria: A, BM, E, K, KUN, KYO, PE, NY, TI, TNS, US and XJBI, particularly, I had opportunities for visiting the herbaria of Academia Sinica, Beijing (PE) and Xinjiang Institute of Biology, Soil and Desert Sciences, Urumqi (XJBI), China recently, where I could observe a great number of the specimens of *Orostachys*. I noted that some taxa which possess remarkable specific features are still remaining uncertain, and some fall in synonymy.

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1) On *Orostachys minutus* (Komarov) A. Berger

Komarov (1901) considered two specimens collected by himself in Schuanczacho, Kirin (now Jilin), NE China and Cza-schin-gan, Kenge Prov., N Korea, to be different from *O. spinosus* by the colour of bracts, the shape of sepals and petals, the shape and colour of anthers and the length ratio between calyx and corolla, and named them *Cotyledon minuta*. His description is meticulous but lacks explanation on the characters related to the apical part of the rosulate leaves, which are quite significant to consider the affinity or relationship. As pointed out by Komarov, if *O. minutus* is closely related to *O. spinosus*, it must possess a sharp cartilaginous prickle or spine at the apex of rosulate leaves.

Fu (1984) regarded *O. minutus* as a distinct species distributed in Heilongjiang and Liaoning Provinces as well as Korea. I found seven specimens determined by him as *O. minutus* at Beijing (PE). Among them, a single collection from Jilin Prov., Antu Pref., Baitoushan (Fu Peiyun & al. 1204) is *O. malacophyllus*, and the other six are regarded as *O. fimbriatus* with more or less incised cartilaginous appendages at the apex of rosulate leaves; these are from Liaoning Prov., Qianshan, Cixiangguan (Liou Tchen-ngo & al. 6942), Qianshan (Wan Zhan & Liu Ying-hsin 1278), Jiguanshan (J. Sato 789); Hubei Prov., Zhangbei (Unknown coll. 3871); Inner Mongolia (Nei Mongol), Duikeng, Beiyunshanpo (Nei Mongol Flora Reserch Group 303), Hinglongshanzhen (Unknown coll. on 23 Oct. 1918).

Though I could not examine the type specimens, I observed several specimens of dwarfish *Orostachys* from Korea with cartilaginous prickles. These are from: Hamkyong-puk Do, Chongsung, Posangdo (T. Nakai 7082, TI); Keikwansan (J. Sato 5, TI); Canyon east of Chipori, near 38°08′ N, 127°19 1/2′ E (R. Moran 5277 A, TI); Kyongsangpuk Do, Wha, Taehyounli, alt. 780 m (Li Woo Tchul on 25 July 1986, TI). In these the flowering stems are cylindrical and less than 10 cm long, of which the cauline leaves (sometimes withered up) are shorter than the rosulate leaves. The cartilagineous appendages are semi-orbicular with an apiculate apex. The petals are narrowly oblong, 4.8 to 6.5 mm long and apparently shorter than the stamens (6 to 7 mm long). These appearances of characters fall in the variation range of those of *O. spinosus*, and also no clear difference was found in the distinguishing characters between these two species by Komarov. Therefore, these specimens are considered to be only the dwarf representatives of *O. spinosus* though the stamens are slightly longer than the petals. I have examined the

types of *O. filifera* (Nakai) Nakai (in Journ. Jap. Bot. **18**: 215, 1942) based on *Cotyledon filifera* Nakai (in Bot. Mag. Tokyo **33**: 54, 1919) and *O. kanboensis* Ohwi (in Acta Phytotax. Geobot. **11**: 249, 1942): In rupibus Montis Kanbōhō 1600 m et supra (Nakai 7087, TI, type of *C. filifera*) and Mt. Kanbōhō (J. Ohwi, cult. in Kyoto, 1 Oct. 1937, KYO, type of *O. kanboensis*). These are also regarded as the dwarf representatives of *O. spinosus* or *O. erubescens* (Maxim.) Ohwi, the latter of which is characterized by the longer linear lanceolate or subulate, more or less terete, cauline leaves with a short spine at the apex and seems to be located between *O. spinosus* and *O. japonicus*.

The type specimens of *O. minutus* probably belong to *O. spinosus* or *O. malacophyllus*. It is needed to examine them to decide the identity. However, most of the specimens determined as *O. minutus* by previous workers are the dwarf representatives of some other species such as *O. spinosus*, *O. malacophyllus* or *O. fimbriatus*.

2) *Orostachys cartilagineus* A. Boriss. (Fig. 1)

Borissova (1939) described *O. cartilagineus*, which was thought to be related to *O. minutus* (Komarov) A. Berger, but different from that by the larger

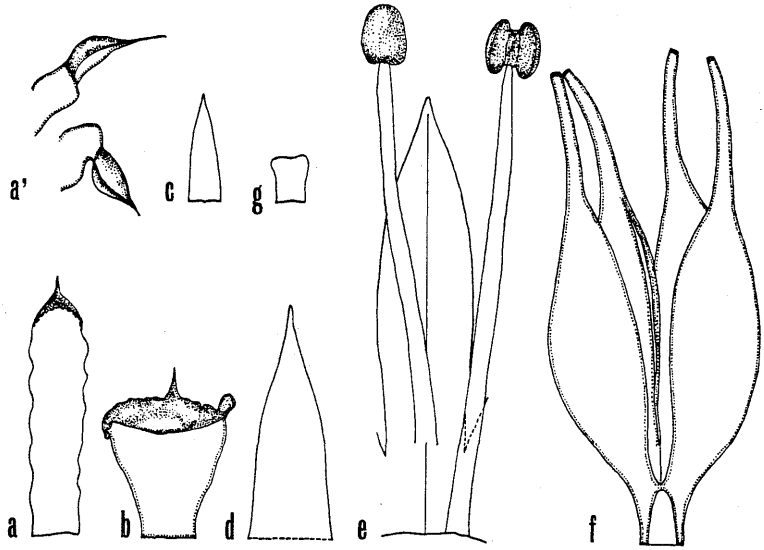

Fig 1. *Orostachys cartilagineus* (Liou et al. 5515). a. cauline leaf and the cartilagineus appendage (*a'*), a ×2, a' ×5. b. rosulate leaf, ×5. c. secondary bract, ×5. d. calyx-lobe, ×10. e. petal with stamens, ×10. f. gynoecium, ×10. g. nectar-scale, ×10.

stems, the shape of cartilaginous appendages and the larger bracts. This is, however, quite different from '*O. minutus*' and, in fact, is apparently related to *O. erubescens* (Maxim.) A. Berger and *O. japonicus* (Maxim.) A. Berger, but obviously differs from those by the narrower (subulate or linear-lanceolate) cauline leaves, the petals shorter than the stamens, the stamens connate to the petals about 1.5 mm from the base, and the flowers often 2 or 3 on each axillary branch as well as the prominent cartilaginous appendages. *O. spinosus* (L.) C. A. Meyer differs from this by the apiculate semi-orbicular catilaginous appendage, broadly lanceolate petals, nearly sessile solitary flowers and gynoecium apparently shorter than the petals.

O. cartilagineus resembles *O. fimbriatus* (Turcz.) A. Berger in having a remarkable cartilaginous appendage. The cartilaginous appendage of *O. cartilagineus* is prominent and resembles a claw of birds with entire margin and a very sharp prickle attaining 2 mm long (Fig. 1), and that of *O. fimbriatus* is also conspicuous but has more or less deeply incised margin. Moreover, it is remarkable that the arrangement of leaf epidermal cells is different from each other. In *O. fimbriatus* the cells regularly arrange in longitudinal rows while in *O. cartilagineus* they are not longitudinal but oblique.

O. cartilagineus is regarded as a distinct species with such remarkable features mentioned above, and distributed in a narrower range from E and NE China probably to N Korea but not to Japan, though Borissova cited Japan in the locality.

Orostachys cartilagineus A Boriss. in Komarov, Fl. URSS **9**: 89, 368 (1939), versim. pro parte, excl. Japoniae in habit.

'*O. japonicus*' Kitagawa, Lineam. Fl. Mansh. 246 (1939), p. p., (non Berger).

[Additional description of flowers] Flowers solitary or often 2 or 3 on each axillary branch with a prominent peduncle; the secondary bracts triangular or subulate, 3–5 mm long. Calyx tube 1–1.2 mm long, the lobes narrowly triangular ovate—broadly lanceolate, shortly acuminate or acute at the apex, 2.6–3.1 mm long, 0.9–1.1 mm wide, probably punctate with purple dots. Petals 5.5–6 mm long (1–1.2 mm connate from the base), linear-lanceolate-oblong-lanceolate, acute at the apex, suberect at anthesis. Stamens slightly shorter or longer than the pistils, and obviously longer than the petals, 6–7 mm long; anthers ovate, probably deep red before dehiscence. Gynoecium 5.5–6.5 mm long, tapering towards the apex, truncate and smooth at the apex. Ovules 10–12 in each locule, ca 0.6 mm

long. Nectar-scales square or broadly oblong, ca 0.6 mm long, ca 0.4 mm wide.

Specimens examined. E China. SHANTUNG Prov., Tsingtao Island, along rocky slope, alt. 15 m (C. Y. Chiao 2526, PE); Muping, Kuishanan, alt. 280 m

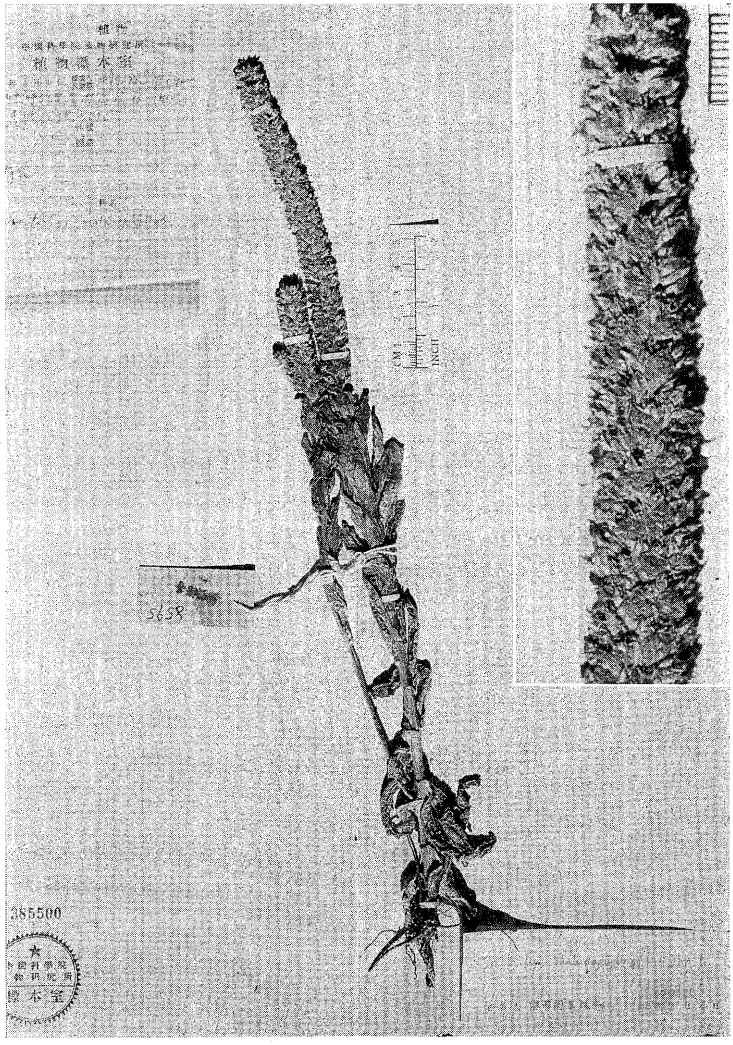

Fig. 2. Type of *Orostachys malacophyllus* subsp. *Lioutchenngoi*.

(T.N. Liou & K.M. Liou 1634, 1635, PE); Laoshan, on way from Pan-fang to Hwang-hua-an, alt. 400 m (Y.C. Wang 571, PE); near Chefoo (C.C. Su s.n., PE). NE China. LIAONING Prov., Zhuanghe Pref., Qiansanshan ([illegible] 4, PE); Zhangwu Pref., Zhanggutai, Liangjiazi (Liou Tchen-ngo 5515, PE); Xiuyan Pref., Tangchi Xiangtoudao Dadui, Dalazigou (Wang Wei & al. 1390, 1414, PE). HEILONGJIANG Prov., Ning'an Pref., Jihuanzhen, Pingdingshan, alt. 400 m (Fu Pei-yun & al. 1187, PE).

3) A subspecies of *O. malacophyllus* from Inner Mongolia

Several specimens of *O. malacophyllus* collected from Dahingganling Range, N Inner Mongolia represent a remarkable form which has elongate stems, less than half of which is occupied by inflorescences, and lacks rosettes in the flowering individuals at the flowering season. This form seems to be restricted in Dahingganling Range, and is regarded as a geographical subspecies of *O. malacophyllus*. The epithet is dedicated to Dr. Liou Tchenngo, (1897-1975), who was a prominent Chinese botanist, and particularly contributed to the researches of the flora of N China and the vegetation of China.

Orostachys malacophyllus (Pallas) Fisch.

subsp. **Lioutchenngoi** H. Ohba, subsp. nov. (Figs. 2 & 3).

A typo bene differt: inflorescentiis anguste cylindricis, longitudine circa dimidio supero cauli occupantis et in anthesis erosulata.

Planta ad 33 cm alta, sparsissime ramosa in anthesis erosulata. Caulis glaber, laevis, basi 5 mm latus, erectus. Folia caulifera (internodis 1.5-1.7 cm longis), infera linearia vel lineari-oblanceolata, supra gradualiter oblanceolata ex lineari-oblanceolata, apice rotundata, utrinque glabra, infera 4-5.5 cm long, 8-10 mm lata, supra 4-4.5 cm longa 6-7 mm lata.

Inflorescentia anguste cylindrica, et basi et apice 9-14 mm lata, (5-) 12-14 cm longa, longitudine circa dimidio supero cauli occupantia. Bracteae late vel modice obovatae, 6-8 mm longae 4-5 mm latae, apice acutae vel brevisissime acuminatae, basi attenuatae, margine vulgo sparse denticulatae vel integerrimae; dentis numero 7-12, late triangularibus, apice obtusis, 0.2-0.3 mm altis.

Flores solitarii, pedicellati, pedicello ca. 1.5 mm longo. Calyx 5-6.2 mm longus 1.4-1.6 mm latus, tubo ca. 1 mm longo, lobis oblongis vel oblongo-lanceolatis, apice gradatim attenuatis. Petala 5-6 mm longa ca. 1.6-1.8 mm lata, basi ca. 1 mm connata, parte libero oblonga, apice circa late rotundo- vel semi-orbiculari-triangularia apice ipso rotundata vel obtusa, erecta ad anthesin. Stamina numero

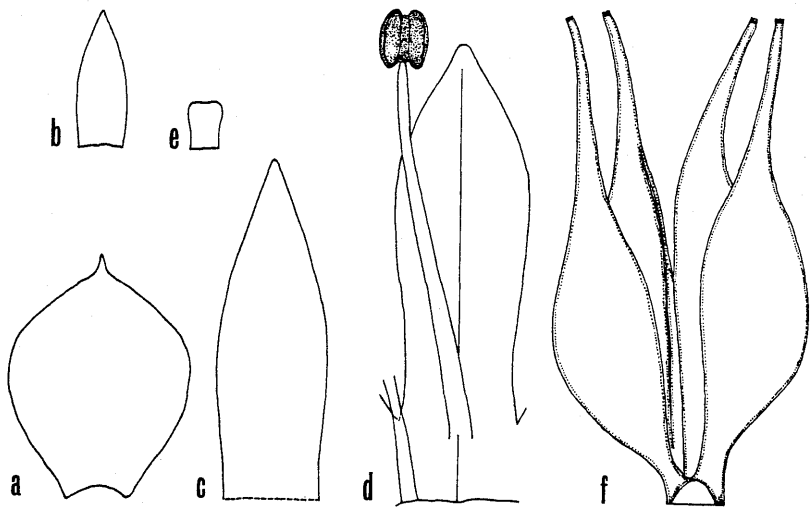

Fig. 3. *Orostachys malacophyllus* subsp. *Lioutchenngoi* (Liou 8595). a. bract, ×5. b. secondary bract, ×5. c. calyx-lobe, ×10. d. petal with stamen, ×10. e. nectar-scale, ×10. f. gynoecium, ×10.

10, 5.5–6.7 mm longa, filamentis erectis, filiformibus, antheris late ovatis ante dehiscentim saturate luteis. Glandulae oblongae apice truncatae vel emarginatae, ca. 0.4 mm longae ca. 0.3 mm latae. Gynoecia 5.5–6 mm longa; ovario 1.2–1.4 mm lato, basi prominenter stipitato, apice contracto, stylo ca. 1.5 mm longo. Ovula in quoque loculo numero 30–40, ca. 0.4 mm longa.

Typus: China. INNER MONGOLIA. Hunameng, Xuguitqi, near Gen He (Liou Tchen-ngo 8595, PE).

Other specimens examined. INNER MONGOLIA. Dahingganling, Gen He, Haolibu chezhan (Liou 8932, PE); Manzhouli, near Nanshan (Liou 8336, PE); Fulunqi, Honghuaerji (Liou & al. 8290, PE).

4) *Orostachys thyrsiflorus* (Fisch.) A. Berger

Maximowicz (1883) is the first botanist to define the differences between *O. thyrsiflorus* and *O. spinosus* (L.) C.A. Meyer under the genus *Cotyledon*. He distinguished the former from the latter in having very distinct pedicellate, white flowers, length of calyx one-third of the corolla, 'discolor' anthers and pedicels often with many flowers in the lower part of the inflorescence. *O. spinosus* has short pedicellate, yellow petals, length of calyx half of the corolla, unicoloured anthers, and always uniflorous pedicels. Fröderström (1931) con-

sidered *O. thyrsiflorus* as a variety of *O. spinosus*, and distinguished this from that by the usually denticulate-cartilaginous basal (=rosulate) leaves, the rather broad and lax inflorescence, and the more or less pedicellate flowers with semi-orbicular and narrow acuminate sepals, subsemiovate petals of 6–7 mm long and larger broadly winged seeds.

The apex of rosulate leaves is cartilaginous and often denticulate in *O. thyrsiflorus*, while in *O. spinosus* it is never denticulate but sometimes irregularly incised, particularly in aged or larger leaves. The differences in denticulation between these two species are quite significant in *Orostachys*. The petals of both species share the same shape and size, that is, they are narrowly oblong or narrowly oblong-lanceolate and 5.5–6(–7) mm long. In my observation the size of seed and the width of the wing are hardly different between them. Other characters noticed by Maximowicz and Fröderström in inflorescence and flowers are stable.

O. thyrsiflorus is distributed in Tian Shan, Altay, Kirghiz, and southern Siberia to the Ural Mountains (fide Fröderstöm). Its range is partly congruent with that of *O. spinosus*, particularly Tian Shan and Altay mountains. However, I could not find any intermediate form between them at least in the specimens collected from both mountains.

Thus, *O. thyrsiflorus* is enough to be recognized as a distinct species closely related to *O. spinosus*, showing a weak morphological differentiation from that.

The distinguishing characters between them are as follows:

Flowers nearly sessile; sepals triangular-ovate or ovate to narrowly ovate; gynoecium apparently longer than the petals; inflorescences narrower and denser ..... *O. spinosus*

Flowers pedicellate; sepals broadly triangular-ovate; gynoecium as long as or a little longer than the petals; inflorescences broader and laxer .... *O. thyrsiflorus*

Specimens examined. China. XINJIANG. ALTAY MTS. Burqin, Kanasi river, Sal-gerl, alt. 500 m (Ching 3255, PE); Altay Pref., Namgebi, alt. 550 m (Ching 2857, PE). TIAN SHAN MTS. Aksu Pref., Talazhipei Gongli, Kelazhangmei (Li An-jen & Chu Jia-nan [=Li & Chu] 8497, PE); Kalpin Pref., Jigedaizhaxishui-keng, alt. 2000 m (Li & Chu 7474, PE); Urumqi, alt. 820 m (Coll. Agri.-Aug.-1,

27253, PE); Xijiang, San taidon (Kuan Ke-chien [=Kuan] 4739, PE); Heshuo Pref., Baertu, Muchang—Famuchag, alt. 2300 m (Li & Chu 7019, PE); Qitai Pref., Dashito—Hami (Kuan 5279, PE); Fukang Pref.—Qitai Pref. (Kuan 4393, PE); Baicheng Pref., Kuga, 15 km N (Li & Chu 8220, PE); Wenquan Pref. (Kuan 4565, PE).

5) *Orostachys Chanetii* (Lév.) A. Berger

This species is described on Chanet's collection from Petche-li, Kansu (=Gansu, now). Though Praeger (1921) gave the detailed description based on the living cultivated materials, the identity and the information about variation range of characters, and distribution range are still uncertain in the literature outside of China.

Fröderström (1931) regarded this as the variety of *O. fimbriatus* under the genus *Sedum*. However, the cartilaginous appendage of *O. Chanetii* is broadly ovate or semi-orbicular with spine-like long acuminate apex as well as always entire margin and often deciduous while that of *O. fimbriatus* is almost similar in shape but always prominently incised and persistent. Moreover, all the specimens examined are pyramidal having axillary, leafy branches with 2 to 7 or more, pedicellate flowers in cymose inflorescence and the branches are ascending and gradually shorter towards the apex of the main flowering stem.

The range is restricted to Shaanxi, Gansu and Sichuan. Though Fu (1984) gave Hebei as its locality, I could not examine any specimen from there. Sichuan, where this seems to spread throughout and to be rather common in rocky places or on roof, is the southern border of the range of *Orostachys*, and is thought of as one of the centres of both (infra) generic and specific diversification of the subfamily Sedoideae. It is noticeable that the ovaries of *O. Chanetii* are conspicuously stipitate. This and also the branching nature of the flowering stems are suspected as the most primitive appearances in *Orostachys*. *O. Chanetii* is, therefore, quite significant to detect the phylogenetic diversification and the affinity.

Orostachys Chanetii (Lév.) A. Berger in Engl. Pflanzenfam. 2nd ed. **18a**: 464 (1930); Lauener in Not. Bot. Gard. Edinb. **30**: 290 (1970); Fu in Fl. Reip. Pop. Sin. **43**(1): 41 (1984).

Sedum Chaneti Lév. in Fedde, Repert. **5**: 99 (1908); Praeger in Journ. Roy. Hort. Soc. **46**: 165 (1921), cum fig. 90 & 91.

S. pyramidale Praeger in Journ. Bot. **54**; 42 (1917).

S. fimbriatum var. *Chanetii* (Lév.) Fröd. in Act. Hort. Gothob. **6**: append. 13 (1931).

[Specimens examined]. SHAANXI: Licheng Pref., near Jitouguan (K.T. Fu 6146, PE). GANSU: Wudou Pref., Chengnanshan, alt. 1000 m. On rock cliff (T.P. Wang 14930, PE). SICHUAN: (F.T. Wang 22486, PE), Pehchuan-hsien. At road side (W.P. Fang 5601, PE); Taipaishan, Haopingsze, alt. 1300 m (T.N. Liou & P.C. Tsoong 140, PE); Sungpan-hsien, Sueikowpa, alt. 1700 m. On slope of valley (K.T. Fu 2191, PE); Sungpan-hsien (W.P. Fang 4404, PE); Sungpan-hsien, Nanping, alt. 1450 m (T.T. Yü, PE); Chongqing—Chengdu (T.N. Liou 9786, PE); Jiange Pref., near Jianmenguan (T.N. Liou & P.C. Tsoong 351, PE); loc. cit. (T.N. Liou 11755, PE); Guanghan Pref., alt. 450 m (T.N. Liou & C. Wang 700, PE).

I wish to express my thanks to Directors and curators of herbaria of PE and XJBI as well as A, BM, E, K, KUN, KYO, NY, TI, TNS, and US. I appreciate Professor K. Iwatsuki, University of Tokyo, for facilities.

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イワレンゲ属 *Orostachys* はウラル，パミール以東のアジアに分布し，ベンケイソウ属に近縁であるが，花茎が円柱形に肥厚し，花を密生すること，花弁は基部で合着するなどの違いがある。同属の分類には再検討すべき問題が多い。

1) *Orostachys minutus* (Komarov) A. Berger は中国吉林省と朝鮮北部を原産地として記載された矮性の種である。これまでに検討した標本のうち，朝鮮半島産は *O. spinosus*，中国産は *O. malacophyllus* と *O. fimbriatus* の矮性個体であった。なお，朝鮮北部の冠帽山から記載された *O. filifer* (Nakai) Nakaiと *O. kanboensis* Ohwi も *O. spinosus* あるいは *O. erubencens* の矮性個体に過ぎない。

2) *Orostachys cartilagineus* A. Boriss. は *O. spinosus*, *O. erubescens*, あるいはツメレンゲ *O. japonicus* に近い種で根生葉や茎葉の先端部が顕著に軟骨状になる。

3) アオノイワレンゲ（ゲンカイイワレンゲ）*O. malacophyllus* はたいへん変異の幅が大きい種であるが，大興安嶺には花序が花茎の半分以下で，花時にロゼットが消失する一型がある。これを地方亜種と認め，subsp. *Lioutchenngoi* と命名した。亜種名は採集者でもあり中国植物学に貢献した劉慎諤博士に因む。

4) *Orostachys thyrsiflorus* (Fisch.) A. Berger は *O. spinosus* から明瞭に区別されることを指摘し，アルタイ，天山山脈の標本産地を挙げた。

5) *Orostachys Chanetii* (Lév.) A. Berger が *O. fimbriatus* とは明らかに異なることを指摘した。

□畑中顕和：**みどりの香り　青葉アルコールの秘密**（中公新書 875）230 pp. 1988. 中央公論社，東京．¥600．博物館にいると，近頃は森林浴とかフィトンチッドについての質問がよくある。私はこれらについては，どちらかというと懐疑的な受け応えをしてきたのだが，この本で少しは実のある返事ができるようになった気がする。青葉やキュウリの青臭さは，炭素6個から成るアルコールやアルデヒドに基づく。著者が永年この物質の抽出，同定，合成にたずさわった成果の回顧と展望である。リノール酸から種々の代謝過程を経てこの物質が生成する機作の研究，それが植物の害虫防禦や個体間のコミュニケーションに使われる話，さらに動物では作れないこの物質が，昆虫の摂食活動に重要な役割をするばかりか，体内に蓄積されて社会生活で通信手段に使われたりするという話は，あらためて興味をそそられる。植物名には少々首をかしげるものがあるが，気にしなくてもよいだろう。フィトンチッドでよく言われるテルペン類については触れられていない。（金井弘夫）

□広島県（監修）：**広島県文化百選 7　花と木編** 217 pp. 1990. 中国新聞社，広島．¥1,700．県民や市町村の推薦による名木，景勝地，群落など100件が1頁ずつカラーで示され，対面頁に解説がある。後代に残すべき文化を認識させるため，必要なことではあるが，文中にも各所に記されているとおり，踏み荒らしや採取で減少する心配もある。そちらの方の措置にも配慮してもらいたい。（金井弘夫）